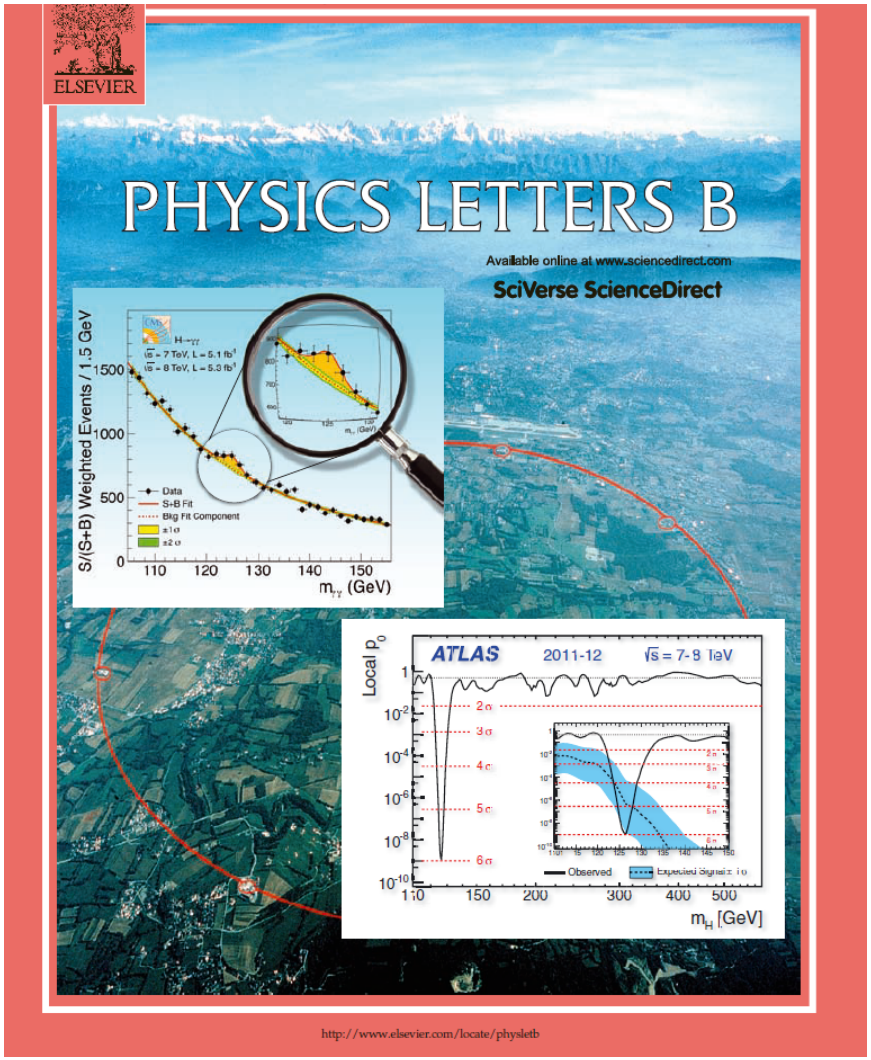
Instrumentation Frontier

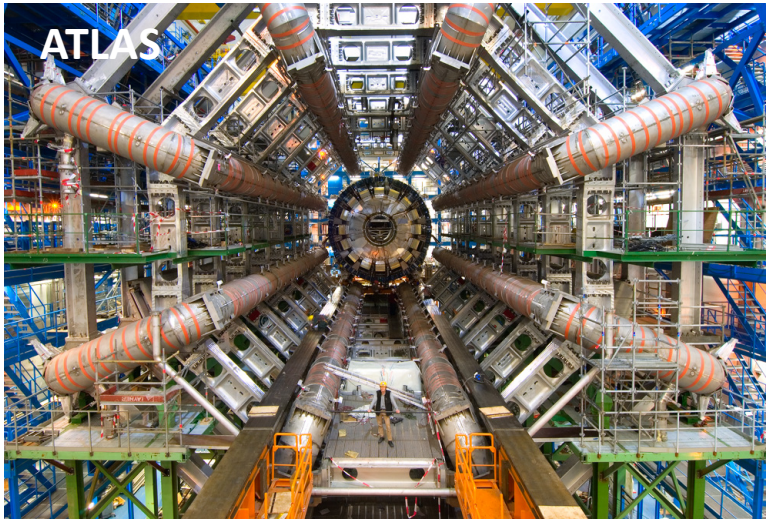
Preamble, Charge and Status

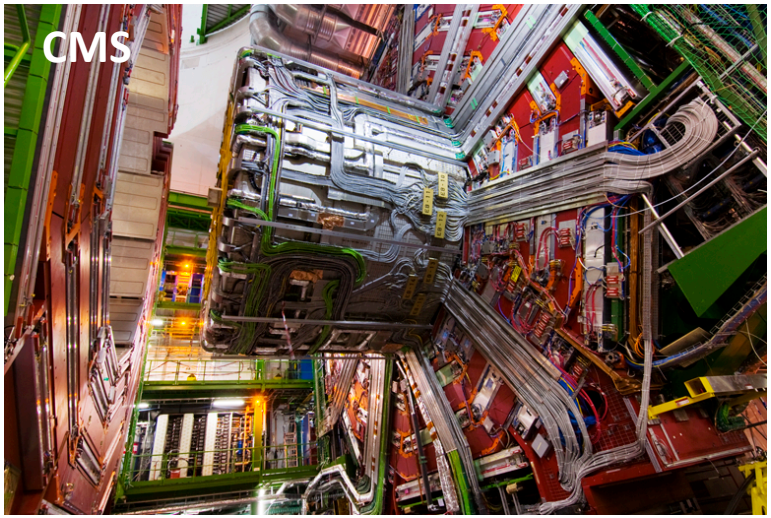
Community Planning Meeting
Fermilab, Oct. 11 – 13, 2012

Marcel Demarteau (Argonne)
Ron Lipton (Fermilab)
Howard Nicholson (Mt. Holyoke)

Triumphs of Instrumentation



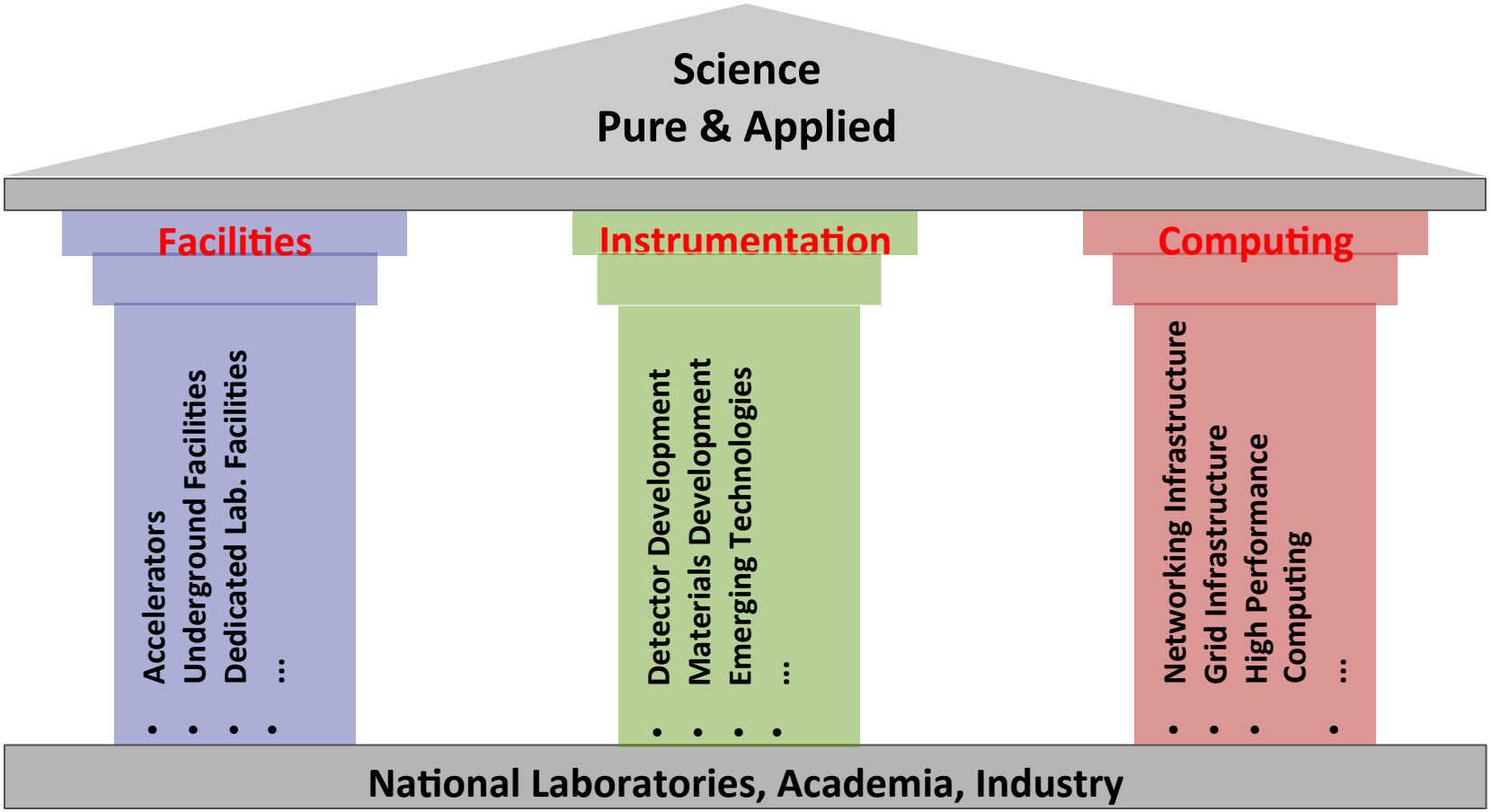




"First observations of a new particle in the search for the Standard Model Higgs boson at the LHC, July 4, 2012", Physics Letters B

Science Enablers

- Science is enabled through the availability of Facilities, Instrumentation and Computational infrastructure



Status

Preface

An exciting time, of momentous opportunity

Significant, fundamental scientific questions

Concepts and technologies exist to address these questions
- **in accelerators**
- **in experiments and detectors**

The challenge (the biggest challenge) is budgetary.
- **How to mount a program of significant experiments and significant opportunity while in a world confronted by environmental and social problems, and economic downturn?**

Andy Lankford, Chair HEPAP, European Strategy Meeting, Cracow, Sept. 13, 2012

- **Put differently: the field cannot afford to maintain the current status quo to have a well-balanced particle physics program**
- **What is the role of instrumentation?**

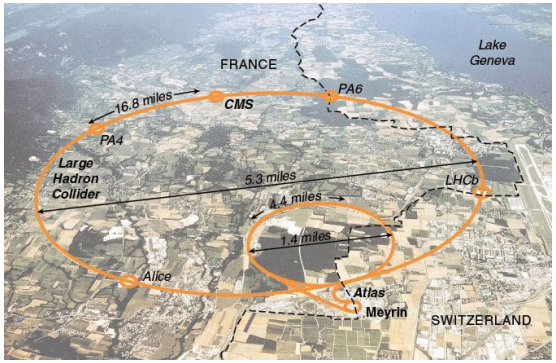
Instrumentation

Science

- The Physics Questions and Challenges are being well formulated by the three physics frontiers; Some questions posed already a long time ago (Higgs, 1964)

Facilities

- Existing facilities will have an extended life
- New facilities are costly; environment is very competitive



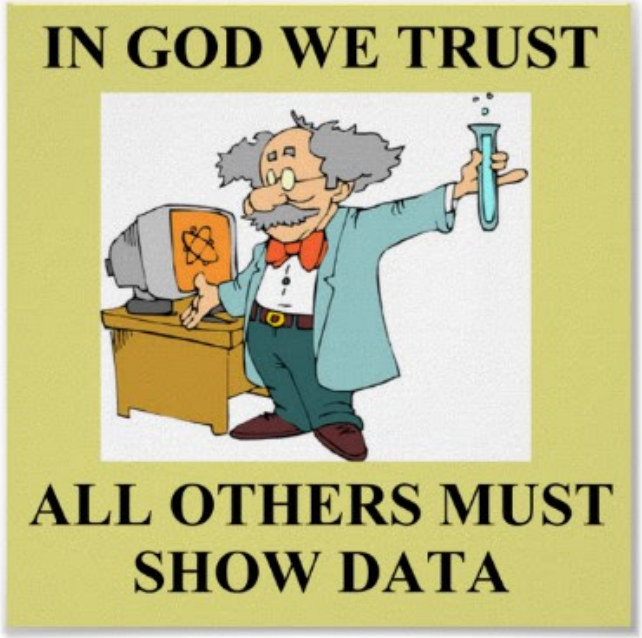
Instrumentation

- New instrumentation to get the most out of existing, upgraded facilities
- Cost-effective innovative techniques and technologies for new experiments

Instrumentation will have a tremendous impact on the future program

Role of Instrumentation

- We have to face reality:
  - Acknowledge the socio-economic situation
  - Acknowledge the budgets and their projections
  - Acknowledge the developments elsewhere
  - ...
- Within the constraints, develop a compelling program



- **Instrumentation can play a crucial role in maintaining the vitality of the field**

✓ For existing experiments, such as LHC experiments, preservation of Knowledge and Technical Expertise

✓ The best way to preserve/create knowledge and expertise is to have ongoing construction projects (our projects are usually challenging)

✓ In-house technical expertise – at Laboratories and Universities – is indispensable and vital in the successful delivery of large system

Role of Instrumentation

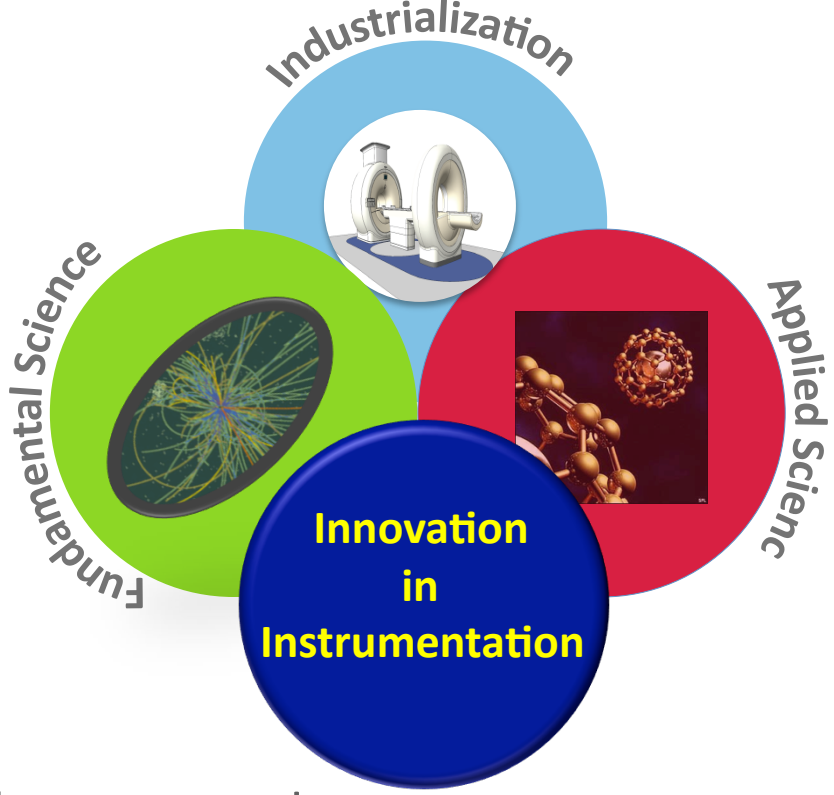
- ✓ Instrumentation allows young people to get involved in projects that may be more than a decade away from realization.
- ✓ Investment in instrumentation can allow us to keep a leadership role in the science when flagship facilities are offshore.
- ✓ The goal of instrumentation is NOT incremental improvements of existing technology, but the development of new cost-effective transformative technologies; the emphasis is on innovation
- ✓ Track technologies and combine the advances in all areas of science and applying them to address prominent scientific questions: multi-disciplinary approach

- ✓ Break the isolation and export our key successes to other areas of science and to society at large through technology transfer to industry

- **The field of high energy physics is very good at instrumentation**
- **Need to reinvest in instrumentation in a modern, broader context**

Don't Be Risk Averse

- Innovation in instrumentation has been a hallmark of HEP with a singular focus
- Renewal of that investment for cost-effective HEP experiments in a modern context: using advances in other sciences for HEP and transferring knowledge to industry to broader societal application

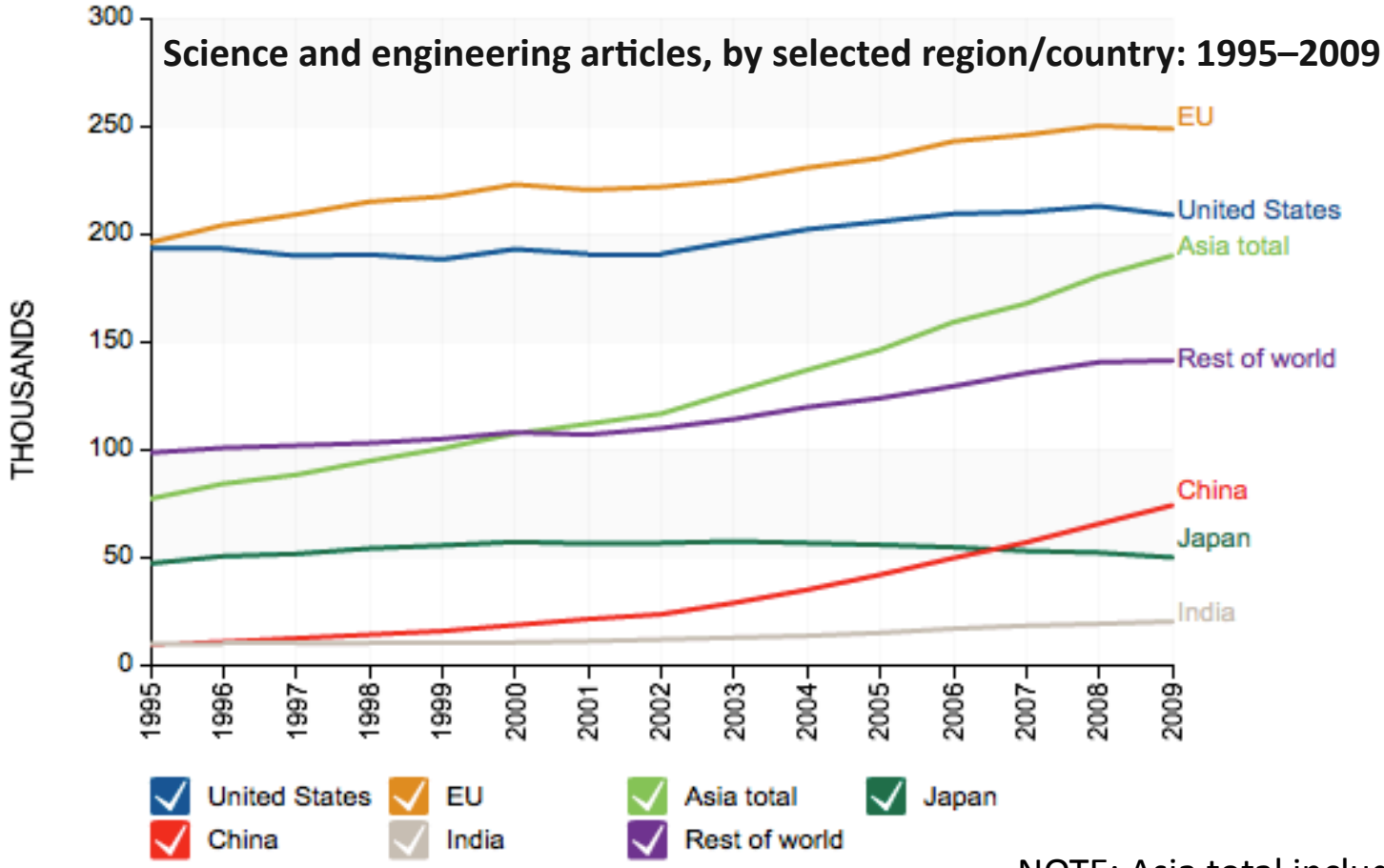


Going back to old Bell Labs model respecting current socio-economic environment

- Need to go back to our roots!

Leverage an Unfair Advantage

- ... It will benefit society as a whole and will be appreciated



Source: Science and Engineering Indicators (SEI) 2012
Global Patterns of R&D Expenditures, Chapter 5.

NOTE: Asia total includes China, India, and Japan.

http://www.nsf.gov/statistics/seind12/

History

- "Television won't last because people will soon get tired of staring at a plywood box every night." - Darryl Zanuck, movie producer, 20th Century Fox, 1946.

- "That the automobile has practically reached the limit of its development is suggested by the fact that during the past year no improvements of a radical nature have been introduced." - Scientific American, Jan. 2 edition, 1909.

Snowmass

Charge and Process

Charge

- To provide an evaluation of the detector development program being carried out in support of the science mission; to identify the challenges in instrumentation; to determine if the existing program meets the science needs; to suggest a program to strengthen the field.
  - identify either incremental or transformational technologies that would enable research in a given physics frontier
  - Identify those areas of detector R&D that could substantially reduce the cost of future experiments in a given frontier.
  - Formulate a detector R&D program including resources and facilities that optimizes generic and specific detector R&D across the physics frontiers for a well-balanced program.
  - Formulate a program to educate future HEP physicists with a fundamental understanding of detectors and instrumentation

Snowmass and CPAD

- Following the recommendation of the 'DPF Taskforce on Instrumentation', DPF appointed a Coordinating Panel for Advanced Detectors (CPAD) with a charge similar to the Snowmass charge
- Snowmass is a one-time event
- CPAD is a standing panel
- Fully integrated CPAD in Snowmass process; Snowmass report will be executed by CPAD

Instrumentation in Particle Physics

Commissioned by the Executive Committee of the Division of Particles and Fields, American Physical Society

October 2011

Prepared by the Task Force Members:

Authors: Marina Artuso (Syracuse), Ed Blucher (Chicago), Ariella Cattai (CERN), Marcel Demarteau (co-chair, ANL), Murdock Gilchriese (LBNL), Ron Lipton (FNAL), David Lissauer (BNL), David MacFarlane (SLAC), Bill Molzon (UCI), Adam Para (FNAL), Bruce Schumm (UCSC), Gabriella Sciolla (Brandeis), Ian Shipsey (co-chair, Purdue), Harry Weerts (ANL) Ex-officio: Chip Brock (Michigan State), Patricia McBride (FNAL), Howard Nicholson (Mount Holyoke).

http://dl.dropbox.com/u/24655052/dpf_report_v11.pdf

CPAD Membership

- Members of CPAD
  - Jim Alexander, Cornell University (jim.alexander@cornell.edu)
  - Marina Artuso, Syracuse University (artusomarina@gmail.com)
  - Edward Blucher, University of Chicago (blucher@hep.uchicago.edu)
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  - Howard Nicholson, Mount Holyoke (**) (hnichols@mtholyoke.edu)
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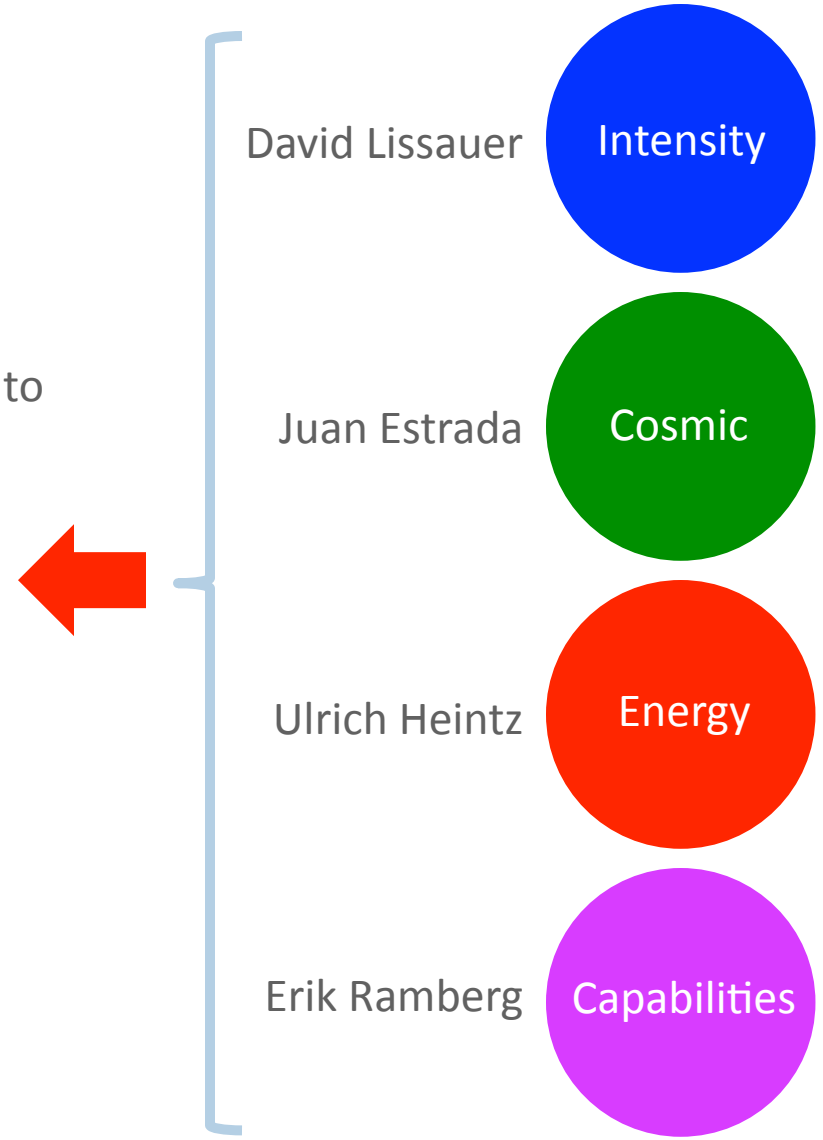
  - Bob Wagner, Argonne (rgwcdf@hep.anl.gov)

http://www.hep.anl.gov/cpad/index.html

*: co-chairs
**: ex-officio

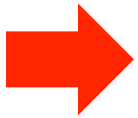
Diagonalization

- Parameter space to cover is huge:
  - 4 frontiers
  - Many different existing and future facilities
  - Vast spectrum of technologies
  - Long time horizon which is inherent to R&D
- For each frontier, identified one contact person with Frontier Instrumentation for this workshop
- Each frontier quickly involves many technologies ...



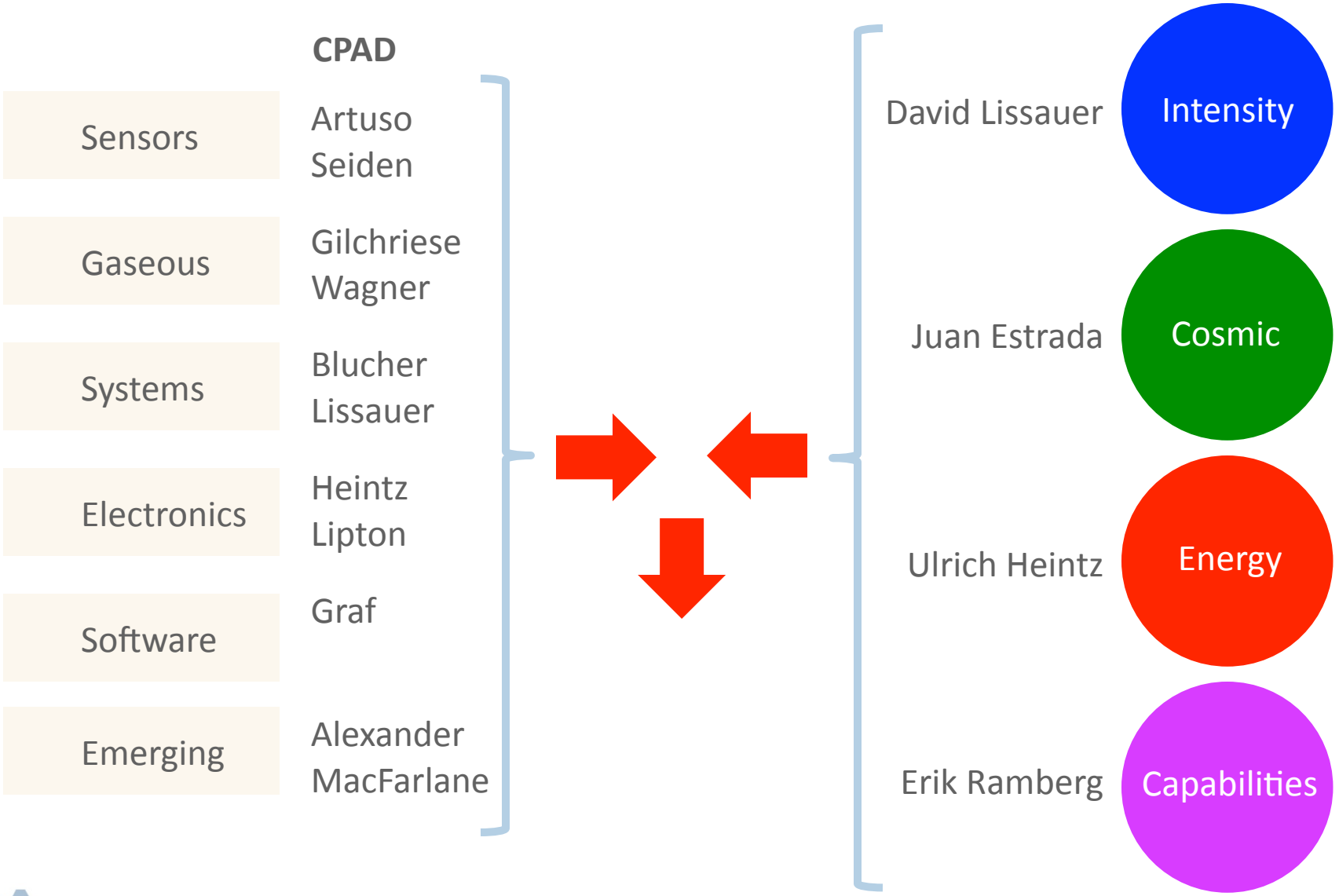
Diagonalization

	CPAD
Sensors	Artuso Seiden
Gaseous	Gilchriese Wagner
Systems	Blucher Lissauer
Electronics	Heintz Lipton
Software	Graf
Emerging	Alexander MacFarlane



- Diagonalization along technologies
- Defined six technology categories – any categorization has its limitations
- Two CPAD members assigned to each category

Perspective from Two Diagonalizations

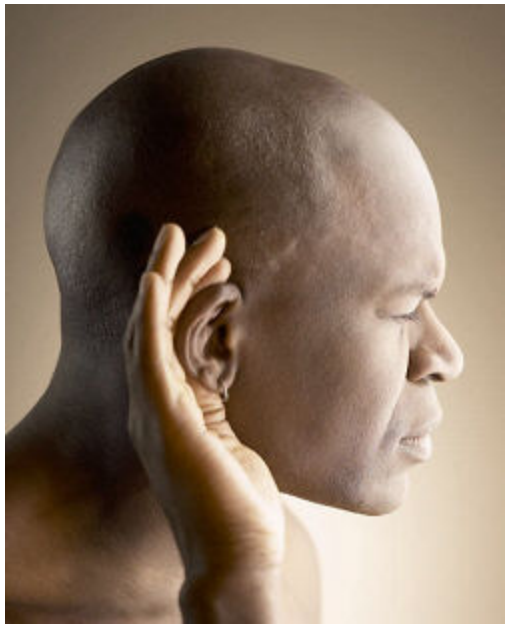


Liaison Matrix

	Energy	Intensity	Cosmic	Facilities
Sensors				
Marina Artuso	Daniela Bortoletto	Matt Wetstein	Andrei Nomerotksi	Carsten Hast
Abe Seiden	Sally Seidel	Jerry Va'vra	Clarence Chang	
		Prisca Cushman	Jim Fast	
Gaseous Detectors				
Gil Gilchriese	Andy White	James White	David Nygren	
Bob Wagner	Marcus Hohlmann	Brendan Casey	Dan Akerib	
	Vinnie Polychronakos		Greg Tarle	
Detector Systems				
Ed Blucher	Roger Rusack	Bonnie Fleming	Karen Byrum	Erik Ramberg
David Lissauer	Adam Para	Bob Svoboda	Peter Gorham	Jae Yu
			Erik Gottschalk	
Electronics/DAQ/Trigger				
Ulrich Heintz	Dong Su	Gary Varner	Günther Haller	
Ron Lipton	Wesley Smith	Yau Wah	Frank Krennrich	
	Maurice Garcia-Sciveres			
Novel/Emerging Technologies				
Jim Alexander	Ted Liu	Steve Ahlen	Juan Estrada	
David MacFarlane	Julia Thom			
Software				
Norman Graf	Erich Varnes	Robert Kutschke	Salman Habib	

CPM

- Our primary goal for this meeting is to listen!



- We want to hear from the physics and capability groups the needs, challenges and goals
  - What are the opportunities and limitations in the technologies currently used ?
  - Where are incremental improvements adequate ?
  - Where are transformational technologies needed ?
  - Where are technologies not used efficiently ?
  - What technologies should be studied ?
  - What new technologies can be married with new experiments ?
  - ...

- We're not really interested in scaling existing, familiar technologies; We're interested in new ideas !

Instrumentation Sessions Tomorrow

- Liaisons will participate in all Frontier sessions

- Dedicated joint sessions with Instrumentation

  1:15 - 2:15 Joint with High-Energy Frontier (Auditorium)

  12:00 – 13:00 Joint with Intensity Frontier (One West)

  12:30 - 13:15 Joint with Cosmic Frontier (Curia II)

  12:30 - 13:15 Joint with Capabilities (Fish Tank)

- Dedication Instrumentation sessions

  9:30 – 10:30 CPAD Meeting (Hornet's Nest)

  14:30 - 15:15 Instrumentation subgroups discussions
  Liaison with Energy (Black Hole)
  Liaison with Cosmic (Comitium)
  Liaison with Intensity (Snake Pit)
  Liaison with Capabilities (Theory, WH3NE)

  15:15 - 16:00 Instrumentation plenary session

Beyond CPM

- CPM, October 11 – 13, 2013
  - Develop a good overview of science goals and instrumentation used to pursue these goals
- Dedicated workshop at Argonne, January 9 – 11, 2013
  - Provide complete overview of capability and technical development among the US HEP detector R&D community, including the HEP laboratories.
  - Initiate the process of identifying areas of overlapping interests and plans.
  - Include other science disciplines such as materials science, basic energy science, nano-materials.
  - Provide a forum for the presentation of ideas for new research directions and form collaborations with laboratory experts.
- Dedicated workshop in Boulder, CO, following the APS April meeting, April 17 – 19 (tentative)
  - Continue process started at Argonne
- Snowmass in Minneapolis, July 29 – August 10, 2013
  - Final Report

- CPAD continues the work and starts implementation of a program

Priorities

- Priority is to enable our science, balanced across the 3 frontiers, by developing cost-effective instrumentation
- Interact with other science disciplines and use material science, computing, nano scale, basic energy science etc. in order to enable new technologies for use by HEP
- Break down walls between programs and increase connections to other Office of Science programs
- Transfer HEP expertise to other fields in detector & accelerator technology and to industry for the benefit of society at large
- Retain vital expertise and facilities – at universities and national laboratories – to mount future projects

Summary

- **Instrumentation does not have a CD process !**
- R&D and not failing are incompatible !
- We need to go back to our roots, challenge ourselves and make our experiments affordable again
- Need to reinvigorate detector development
  - Work with other science disciplines and industry to learn and to teach
  - Educate new generations of particle physicists
- If interested, please join us !